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(71) Applicant *(for all designated States except US)*: PEVATEC AS [NO/NO]; c/o HydraTech AS, P.o. Box 9113, N-4696 Kristiansand (NO).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: VATNE, Per [NO/NO]; Støle, N-4639 Kristiansand (NO).

(74) Agent: PROTECTOR INTELLECTUAL PROPERTY CONSULTANTS AS; P.O.box 5074 Majorstua, N-0301 Oslo (NO).

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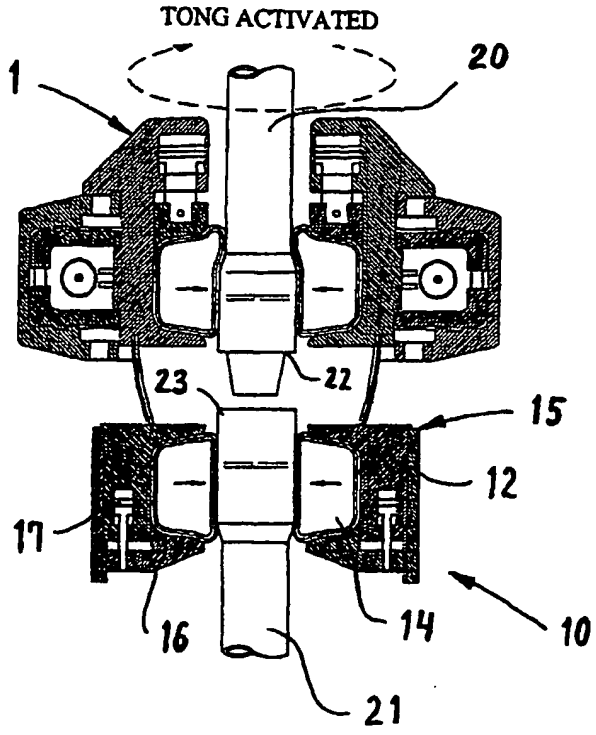
(54) Title: DEVICE FOR FRICTIONAL ENGAGEMENT WITH TUBULAR GOODS



(57) Abstract: A dividable spinner and torque tong (1) for spinning in and tightening of pipe joints (22 and 23) is disclosed. The tong (1) includes an outer stationnary housing (5) having a drive gear (9) connected to a driving motor, an inner rotatable housing (2) having a driven ring (3) in mesh with the drive gear (9). The tong (1) has a number of elements (4) for engagement with a pipe (20). The inner housing (2) has an internal mechanical or hydraulic system (8) that is able to activate the engagement elements (4). Each engagement element (4) is a resilient, incompressible body that is able to undergo alteration in configuration, and each engagement element (4) has a friction forming surface (4F) for direct engagement with the pipe (20).

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DEVICE FOR FRICTIONAL ENGAGEMENT WITH TUBULAR GOODS

The present invention relates to a device for gripping and fixing a tubular, comprising means for subsequent loosening of the grip, which device includes a dividable housing for proceeding towards and embracing the tubular, said housing receives and retains at least one gripping element, which at least one gripping element is activable in order to tighten with heavy force the gripping element against a tubular.

The invention also relates to a dividable spinner and torque tong for spinning in and making up tubular joints, comprising an outer stationary housing having a drive gear connected to a driving motor, an inner rotatable housing having a driven ring gear in mesh with the drive gear, at least one element for gripping a tubular, which inner housing has an internal mechanical or hydraulic system that is able to activate the at least one gripping element.

A spinner and torque tong of this kind is known from NO 163 973, with same inventor as the present invention.

During drilling of wells for oil and gas, either it be onshore or offshore, drilling pipes are used in lengths of approx. 9.5 or 14 meters and diameter 90-170mm. During drilling the wells are secured and consolidated by casings in lengths of approx. 12 meters and diameter 178-510mm. All of these tubulars have threaded joints that are to be made up with a relatively high torque in order to ensure sealing and that the tubular joints do not loosen during rotation. This means that one of the main activities during well drilling is related to make up and break out tubular joints. Totally about 2-4000 such joining operations per well are involved. For the last 25 years mechanised tools have existed for these operations.

The existing mechanised equipment for joining tubulars during drilling operations are classified in two categories, power tongs for drill pipes and power tongs for casings. These are two different tools of which the power tong for drill pipes is permanently installed on drill floor and the casing power tong is assembled each time a casing string is to be run into the well. By existing technology such equipment has to be individually constructed; the casings have thin walled joints while drill pipes have thick walled

joints. Substantial manual work is involved for assembling and disassembling the equipment for casing running operations.

The traditional power tong for drill pipes constitutes two main units; an upper unit with drive rollers for spinning in the threads as long as this operation runs easy (spinner tong), and a lower unit that makes up the joint with a set torque. This means that a complete working cycle consists of many operations that are controlled in sequence. Previously all of these functions were manually controlled, but in the later years, almost without exception, they are PLS-controlled. The mechanical design is basically not suited for automatic sequence control, which in many cases have lead to that the working sequence in automated machines runs slower than manually operated machines.

The present power tong introduces a quite new tong concept that combines spinner tong and torque tong in one unit and in which the tong elements in addition are easy replaceable so that also casings can be run with the same machine.

According to the present invention a device for gripping and fixing a tubular and a dividable spinner and torque tong of the introductory said kind is provided, which device is distinguished in that the at least one gripping element is a resilient, incompressible body that is allowed to undergo deformation, and that the at least one gripping element has a friction forming radially inner surface for direct engagement with the tubular.

In one embodiment the housing is assembled by two main components that are movable in respect of each other and are able to apply force against the resilient, incompressible body such that the body undergoes deformation with expansion in a substantially radially inward main direction.

Preferably the resilient, incompressible body can be of a rubber elastomeric material that encloses a gel or liquid volume.

The resilient, incompressible body can be reinforced, such like steel armoured.

The friction-forming surface may suitably include hard particles, preferably of hard metal that are vulcanised into the elastomeric material.

In one embodiment the one main component of the housing can, in respect of the tubular, be axially moveable towards the second main component and apply a squeeze force against the resilient, incompressible body and cause radially inward directed deformation of the body.

Suitably hydraulic cylinders can exert said axial motion and squeeze force between the main components of the housing.

For the spinner and torque tong, the at least one resilient, incompressible body is activated by means of an internal hydraulic system that is applied by rotation of the spinner and torque tong.

The device for gripping and fixing a tubular, and the dividable spinner and torque tong according to the invention can be incorporated as components in a complete combined power tong that is described in closer detail in co-pending international patent application PCT/NO99/00399 with title: "Combined power tong having integrated mud suction and thread doping apparatus".

Other and further objects, features and advantages will appear from the following description of one for the time being preferred embodiment of the invention, which is given for the purpose of description, without thereby being limiting, and given in context with the appended drawings where:

Fig.1A and 1B show schematically a spinner and torque tong viewed in longitudinal section and from above respectively, and in an inactivated condition,

Fig.2A and 2B show schematically the tong according to fig.1A and 1B in an activated condition,

Fig.3 shows schematically a longitudinal section through the spinner and torque tong, and an underneath located back up tong, in position for spinning in pipe joints,

Fig.4 shows schematically a longitudinal section through the tongs according to fig.3, in position subsequent the spinning in of the pipe joints,

Fig.5 shows schematically the tongs according to fig.1-4 used on a 500mm casing,

Fig.6 shows schematically the tongs according to fig.1-4 used on a 300mm casing,

Fig.7 shows schematically and in perspective the gripping element proper,

Fig.8 shows a cross section through the gripping element according to fig.7, and

Fig.9 shows in larger scale the encircled part of fig.8.

Reference is first given to fig.1A and fig.1B that show the spinner and torque tong 1. The tong 1 has an outer stationary housing 5 and an inner rotatable housing 2. A drive gear 9 is supported in the outer housing 5 and the drive gear 9 is in mesh with teeth of a driven ring gear 3 connected to and supported in the rotatable housing 2. The outer stationary housing 5, the inner rotatable housing 2 and the driven ring gear 3 are dividable, i.e. that they can be opened for proceeding towards a tubular in opened state and subsequently be closed for embracing the tubular. The both housings 5,2 and the driven ring gear 3 have a partition line along which they can be opened. Before opening of the housings 5,2 and the driven ring gear 3, the respective partition lines have to coincide. This means that the inner rotatable housing 2 and the driven ring gear 3 have to be rotated in respect of the outer housing 5 so that the partition line D thereof coincide with the partition line of the outer housing 5.

The inner rotatable housing 2 receives and retains one or more gripping elements 4. The gripping elements 4 are in form of bodies that are both resilient and incompressible. This means that they are not able to change in volume, only in form. The gripping elements 4 will be described in closer detail below in respect of fig. 7-9. The rotatable housing 2 also include a squeeze part 6 that is connected to a hydraulic system that is able to activate hydraulic squeeze cylinders 7 acting directly on the squeeze part 6. The gripping elements 4 are axially and radially restricted outwards by the housing 2 proper and the squeeze part 6 such that deformation can occur in a substantially radially inward direction only. By activation of the hydraulic system the squeeze cylinders 7 are applied

pressure that urge the squeeze part 6 axially against the gripping elements 4 having the housing 2 as an abutment. Thus the incompressible bodies have one way to expand only, namely radially inward toward the tubular. This inward facing surface has a friction face 4F. Also the outwards facing surface may have custom formed friction face, possibly lugs or teeth that mesh with corresponding lugs or teeth in the housing 2.

Fig.2A and 2B show the spinner and torque tong 1 in a conceived activated state (without the tubular) and illustrate the deformation that happens in the gripping elements 4. Between the driven ring gear 3 and the rotatable housing 2, two cylinders, pumping cylinders 8, are arranged diametrically opposite each other. The pumping cylinders 8 are in one end thereof supported in the driven ring gear 3 and in opposite end supported in the rotatable housing 2. The pumping cylinders 8 provide the connection between the driven ring gear 3 and the rotatable housing 2. However, a rotational motion of freedom is present between the driven ring gear 3 and the rotatable housing 2. This motion of freedom is restricted by the stroke of the pumping cylinders 8. The driven ring gear 3 is rotated by means of the drive gear 9 that is driven by a hydraulic motor (not shown).

In the rotatable housing 2 are four cylinders 7 provided, called squeeze cylinders, which are able to urge down the squeeze part 6, which in turn exert pressure against the gripping elements 4. The four squeeze cylinders 7 are in hydraulic communication with the pumping cylinders 8 in a closed hydraulic system.

By rotating the drive gear 9 and thus the driven ring gear 3, the pumping cylinders 8 are compressed. The friction between the squeeze part 6 and the housing 2 is higher than that between the driven ring gear 3 and the housing 2 so that the pumping cylinders 8 are completely compressed before the squeeze part 6 is dragged along in the rotation. This entails that the squeeze cylinders 7 are applied pressure in accordance with the compression of the pumping cylinders 8. This is illustrated in fig.2A and 2B. The motion of the squeeze cylinders 7 leads in turn to that the gripping elements 4 are compressed and receive a smaller inner diameter resulting in a squeeze force against the tubular.

Fig.3 shows a spinner and torque tong 1 that supports a drill pipe 20 ready for spinning into a socket end of a second drill pipe 21. The second drill pipe is retained by a device

for gripping and fixing a tubular, in the following called a back up tong 10. The shown back up tong 10 constitutes the simplest design taking advantage of the invention. The back up tong 10 comprises a stationary divided housing 15 having a main part 12 and a squeeze part 16, which are, in respect of the pipe 21, axially moveable towards each other. In the illustrated embodiment, it is the squeeze part 16 that is displaceable by means of a hydraulic cylinder 17 and the main part 12 acts as abutment. The gripping elements 14 are, by activation of the squeeze part 16, compressed and squeezed radially inwards against the drill pipe 21. The radially inner friction face 14F of the gripping elements 14 makes direct engagement with the drill pipe 21. The back up tong 10 including all components can be opened along a partition line, in order to proceed toward a pipe and subsequently be closed for embracing the drill pipe 21.

Fig.4 shows a situation where the spinner and torque tong 1 has spinned the pin end of the drill pipe 20 into the socket end of the drill pipe 21. During such a spinning in operation, the tongs 1,10 are axially moved towards each other; normally the spinner and torque tong 1 towards the back up tong 10. The squeeze cylinders 17 are activated by an ordinary hydraulic system that supplies pressure to the piston of the squeeze cylinders 17.

Fig.5 shows another situation in which a variant of the spinner and torque tong 1' is used on a 20" casing 30 that is to be spinned into a corresponding casing 31. The casing 31 is fixed by a variant of the back up tong 10'. The spinner and torque tong 1' has a configuration and a moment of force that is in particular adapted to the make up torques applicable for casings.

Fig.6 shows still another situation in which a variant of the spinner and torque tong 1'' is used on a 13 3/8" casing 40 that is to be spinned into a corresponding casing 41. The casing 41 is fixed by another variant of the back up tong 10''. The spinner and torque tong 1'' has a configuration and a moment of force that is in particular adapted to the make up torques applicable for this smaller casing 40.

Fig.7 shows an embodiment of a gripping element 4 and is also illustrating for a corresponding gripping element 14 of the back up tong 10. However, only the gripping element 4 of the spinner and torque tong will be described here. One complete gripping element is put together of two of the illustrated gripping element halves. The respective

element halves may at one point link together in an articulated way, but must be able to open up in order to be able to proceed towards and embrace a tubular 20,21; 30,31; 40,41. As stated, the gripping elements 4,14 are both resilient and incompressible. When the elements are weighted, they will not change in volume, only undergo deformation. The inner surface 4F is intended for engagement with the tubular. The outer surface 4S is lying in the housing 5,15 and forms frictional engagement with the internal surface of the housing 5,15.

As illustrated in fig.8, the gripping element 4 can be constructed by an outer jacket enclosing a gel G or a liquid. One example of the more detailed construction of the jacket 11 is shown in fig.9. The jacket 11 is shown as a laminate having an inner layer 11A of rubber material, an embedded reinforcing layer 11B with steel interlining, alternatively balata, and an outer friction layer 11C of rubber with embedded and projecting hard particles 13 such as particles of hard metal.

It is to be understood that the construction and configuration of the gripping elements 4,14 may assume many variants. The essential is, however, that they have the capacity of being resilient, incompressible bodies. For example, the elements can also have particles 13 embedded in the outer gripping surface 4S that is abutting the housing 5, alternatively in the entire external surface of the element. In extreme situations, it may also be necessary to further increase the friction, for example by providing lugs or teeth internally of the housing 5 and corresponding teeth on the radially outer surface 4S of the gripping elements 4,14.

Patent claims

1.

A device (10) for gripping and fixing a tubular (21), comprising means for subsequent loosening of the grip, which device (10) includes a dividable housing (15) for proceeding towards and embracing the tubular (21), said housing (15) receives and retains at least one gripping element (14), which at least one gripping element (14) is activable in order to tighten with heavy force the gripping element (14) against a tubular (21), characterized in that the at least one gripping element (14) is a resilient, incompressible body that is allowed to undergo deformation, and that the at least one gripping element (14) has a friction forming radially inner surface (14F) for direct engagement with the tubular (21).

2.

A dividable spinner and torque tong (1) for spinning in and making up tubular joints (22,23), comprising an outer stationary housing (5) having a drive gear (9) connected to a driving motor, an inner rotatable housing (2) having a driven ring gear (3) in mesh with the drive gear (9), at least one element (4) for gripping a tubular (20), which inner housing (2) has an internal mechanical or hydraulic system (8) that is able to activate the at least one gripping element (4), characterized in that the at least one gripping element (4) is a resilient, incompressible body that is allowed to undergo deformation, and that the at least one gripping element (4) has a friction forming radially inner surface (4F) for direct engagement with the tubular (20).

3.

A device according to claim 1 or 2, characterized in that the housing (5;15) is assembled by two main components (2;12 and 6;16) that are movable in respect of each other and are able to apply force against the at least one resilient, incompressible body (4;14) such that the body (4;14) undergoes deformation with expansion in a substantially radially inward main direction.

4.

A device according to claim 1, 2 or 3, characterized in that the at least one resilient, incompressible body (4;14) comprises a rubber elastomeric material that encloses a gel or liquid volume.

5.
A device according to any of the claims 1-4, c h a r a c t e r i z e d i n that the resilient, incompressible body (4;14) is reinforced, such as steel armoured.

6.
A device according to any of the claims 1-5, c h a r a c t e r i z e d i n that the friction forming surface (4F;14F) comprises hard particles (13), preferably of hard metal, that are vulcanised into the elastomeric material.

7.
A device according to any of the claims 1-6, c h a r a c t e r i z e d i n that the resilient, incompressible body (4;14) comprises an outer jacket (11) in form of a laminate, including an inner layer (11A) of rubber material, an embedded reinforcing layer (11B) and an outer friction layer (11B).

8.
A device according to any of the claims 1-7, c h a r a c t e r i z e d i n that the one main component (6;16) of the housing (5;15) is, in respect of the tubular (20;21), axially moveable towards the second main component (2;12) and exerts a squeeze force against the at least one resilient, incompressible body (4;14) and causes radially inward directed deformation of the body (4;14).

9.
A device according to claim 8, c h a r a c t e r i z e d i n that hydraulic cylinders (7;17) exert said axial motion and squeeze force between the main components (2;12 and 6;16) of the housing (5;15).

10.
A device according to any of the claims 2-9, c h a r a c t e r i z e d i n that for the spinner and torque tong (1), the at least one resilient, incompressible body (4) is activated by means of an internal hydraulic system (8) that is applied by rotation of the spinner and torque tong (1).

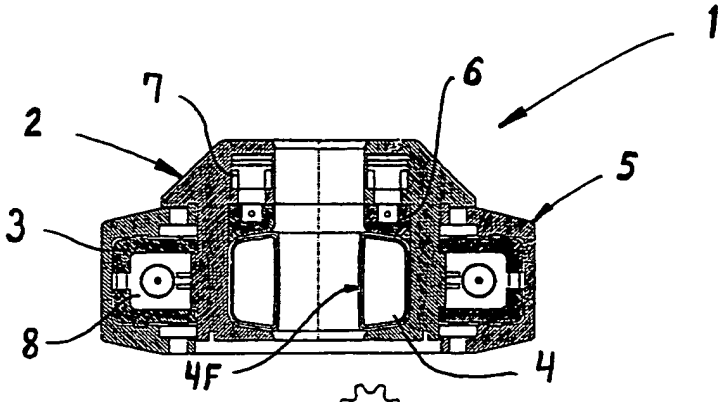

Fig.1A.

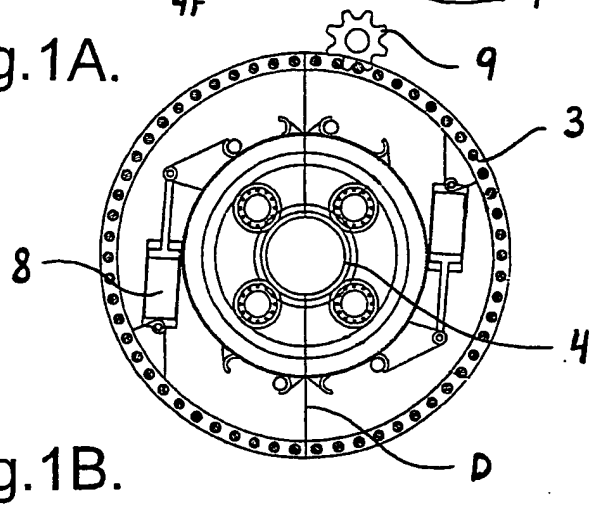

Fig.1B.

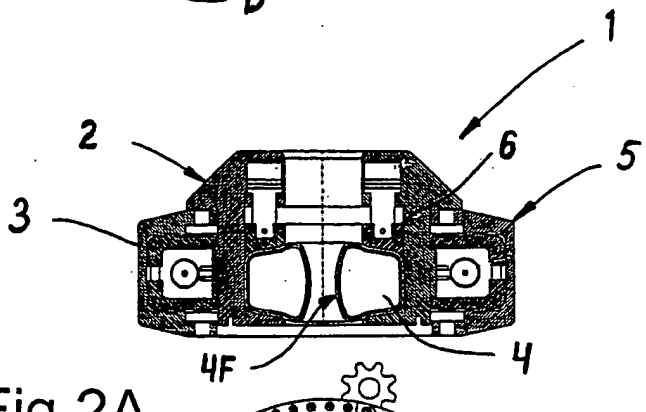

Fig.2A.

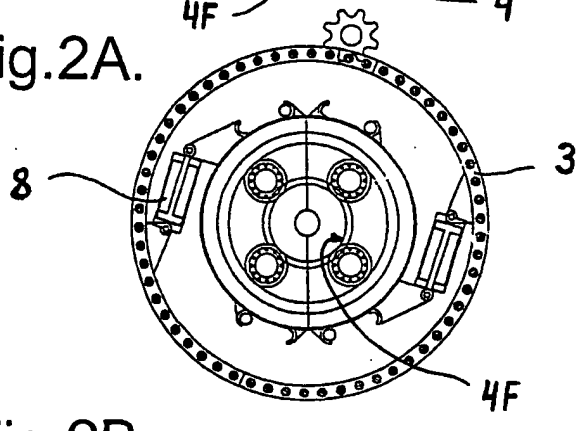

Fig.2B.

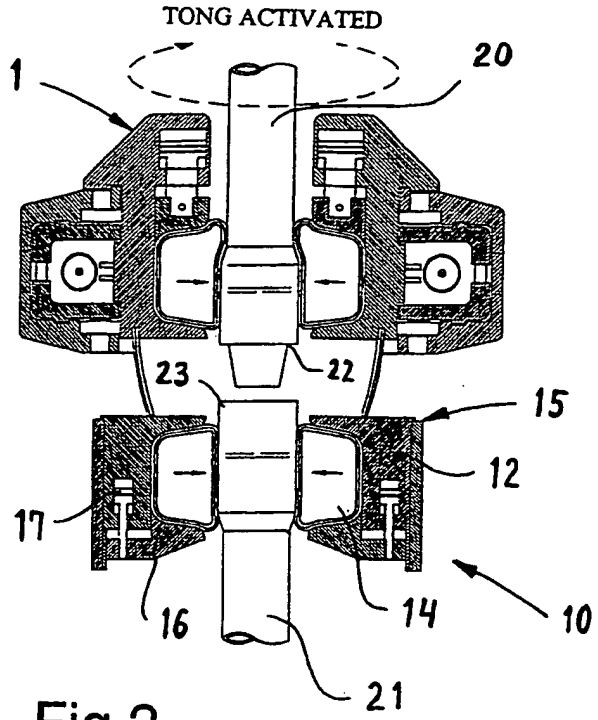

Fig.3.

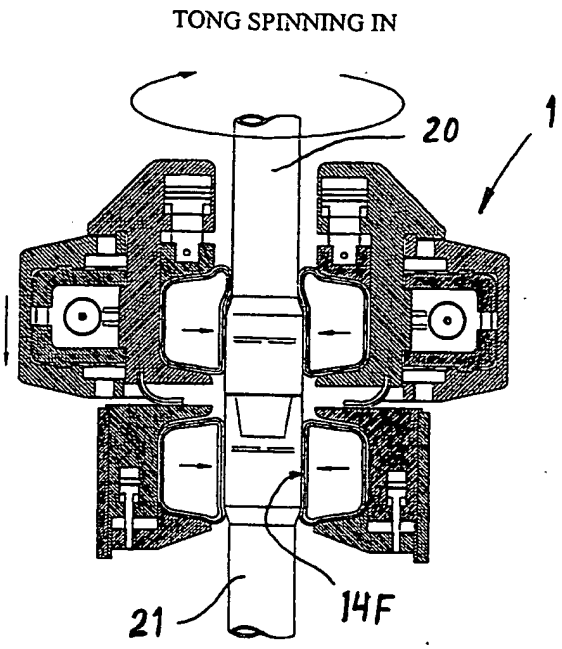

Fig.4.

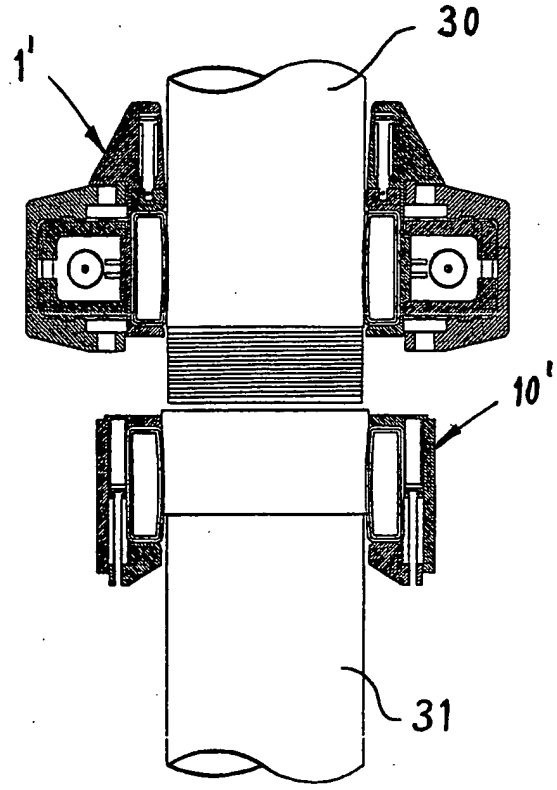

Fig.5.

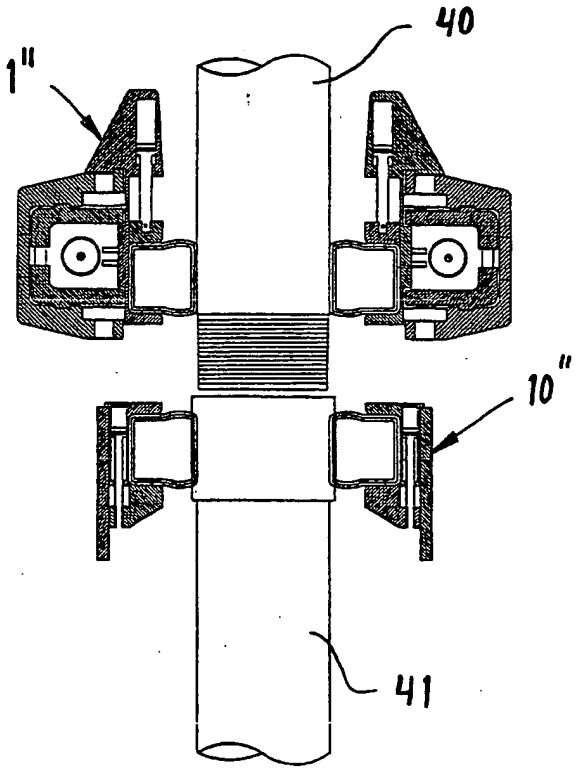

Fig.6.

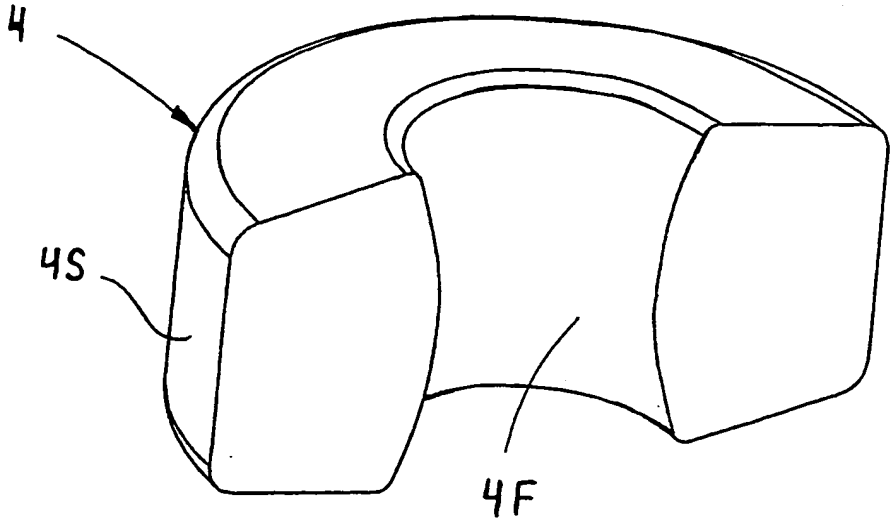

Fig.7.

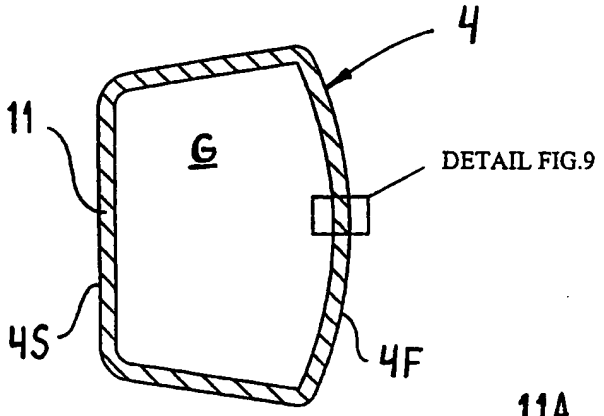

Fig.8.

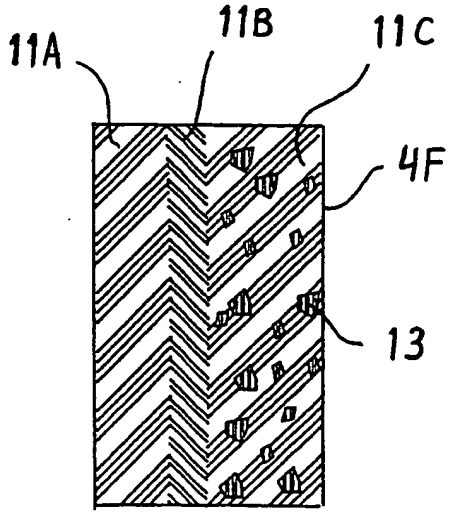

Fig.9.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 99/00400

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21B 19/16
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4989909 A (FRANKS CASING CREW AND RENTAL TOOLS), 5 February 1991 (05.02.91) --	1-10
A	DE 1171837 B (WALBERSDORF SONDERMASCHINENBAU), 18 March 1958 (18.03.58) -- --------	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 Sept 2000	19 -09- 2000
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INTERNATIONAL SEARCH REPORT

Information on patent family members

28/06/00

International application No.
PCT/NO 99/00400

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4989909 A	05/02/91	AT 125236 T	15/08/95
		AU 6297190 A	03/04/91
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		DE 69021066 D,T	21/03/96
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		WO 9102693 A	07/03/91
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